

Neutral pion polarizabilities

September 13, 2019

Theory priorities

We need to plan the theory tasks for the purpose of developing the proposal for PAC 48.

The theory items that need to be worked on are the following:

1) We need to obtain the most general Compton amplitude for $\gamma\gamma^* \rightarrow \pi^0\pi^0$, i.e., when one photon is virtual. This implies that we need the most general definition of the polarizabilities as well. Jose has worked on this but it needs to be finished. Also Svetlana and Alex have looked at this as I remember.

Action:

- i) complete the derivation of the most general Compton amplitude (refs: Tarach; Bardeen and Tung)
- ii) Q^2 (or t) distribution according to experiment.
- iii) ChPT predictions for the Q^2 dependency of the amplitude (one-loop first).
- iv) ChPT at 2-loops: probably here it suffices to look at the work by Bellucci+Gasser+Sainio.

2) Study the dispersive approach to the Compton amplitude (follow some of the classic references such as Dai+Pennington, Oller+Roca, Moussallam). This will require some study. . . .

Action:

start by studying the approaches used by those references. In the stage of analyzing the experimental results and extracting the polarizabilities the dispersive approaches will have to be applied; I am not sure how crucial they are at this earlier stage, but I expect that if we want to give a reliable assessment of the sensitivity of the experiment to polarizabilities we will need to consider them.

It was suggested to try to involve Barbara Pasquini, Bashir Moussallam and Jose Antonio Oller.

3) We need to complete the calculation of the scattering amplitude $\gamma A \rightarrow \pi^0 \pi^0$ where A represents a Coulomb source for now. We need here the one photon exchange contribution. Jose has done this to a large extent, but needs to be polished and finished (also including the most general Compton amplitude point 1) above).

Action:

this needs to be finished (Jose).

4) Make an assessment on the sensitivity of the $\gamma A \rightarrow \pi^0 \pi^0$ cross section with respect to the polarizabilities. Here we will need to understand what has been done in detail, specially Dai+Pennington who seem to have discussed the issue.

Action:

a short cut to the action in point 2)

Look for mesonic t exchange effects that can interfere with the * exchange of the Primakoff (discussion with Svetlana and Alex).

5) In order to extract the Primakoff contribution from experiment one needs to have under reasonable control the other contributions: a) nuclear coherent contributions, b) incoherent contributions, c) final state interactions between π^0 's and the target. All this is probably the most difficult exercise and we should try to find some experts in this type of problem (may be people who did similar work for PRIMEX)

Action:
start looking for help! Sergei Gevorkyan is an expert to be contacted by Ilya.